Incorporation of GNSS Multipath to Improve Autonomous Rendezvous, Docking and Proximity Operations in Space

Completed Technology Project (2011 - 2015)

Project Introduction

Autonomous rendezvous and docking (AR&D) operations depend critically on accurate, real-time knowledge of the relative position and velocity between two space vehicles. Presently, Global Navigation Satellite System (GNSS) techniques have evolved to become a source of high-integrity positioning, velocity and time (PVT) information in nearly all regimes of Earth orbit, from LEO to GEO. Unfortunately, GNSS capabilities remain severely limited in close proximity to large space structures due to significant multipath effects and signal blockage. The proposed research will investigate techniques to improve GNSS navigation in the close proximity of large space structures through the incorporation of multipath as a potential source of new range information, rather than an interference to be mitigated. This analysis is made possible by the newly acquired, full-spectrum GNSS measurements collected on the STS-125 Hubble Servicing Mission 4 (HSM4). This unique data set makes development of these advanced methods for space navigation possible for the first time. The 195 GB of GNSS data from STS-125 will be processed to generate waveforms for all visible satellites. Then a model of the HST-Shuttle geometry will be constructed, employing the Geometric Theory of Diffraction, producing amplitude, delay and phase for each ray path to generate model correlation waveforms. These waveforms will be compared to those extracted from the raw data. The Multipath Estimating Delay Lock Loop (MEDLL) will be applied to the STS-125 data to separate the contributions from each ray path. A simplified geometry model will then be used to define the relationship between the multipath and line of sight rays. The individual delays from the MEDLL will be used to invert this geometry, estimating the relative position vector and attitude. The results of the proposed research will enable the long-term objectives outlined in the NASA Communication and Navigation Systems Roadmap, in particular those in Technology Area Breakdown Structure (TABS) 5.4; Position, Navigation and Timing (PNT).

Anticipated Benefits

The results of the proposed research will enable the long-term objectives outlined in the NASA Communication and Navigation Systems Roadmap, in particular those in Technology Area Breakdown Structure (TABS) 5.4; Position, Navigation and Timing (PNT).

Project Image Incorporation of GNSS Multipath to Improve Autonomous Rendezvous, Docking and Proximity Operations in Space
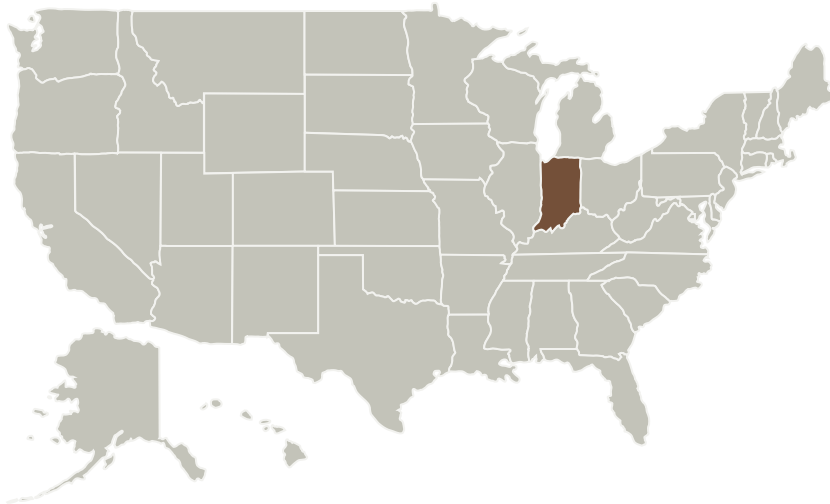
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Primary U.S. Work Locations and Key Partners

Organizations Performing Work	Role	Type	Location
Purdue University-Main Campus	Supporting Organization	Academia	West Lafayette, Indiana

Primary U.S. Work Locations
Indiana

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

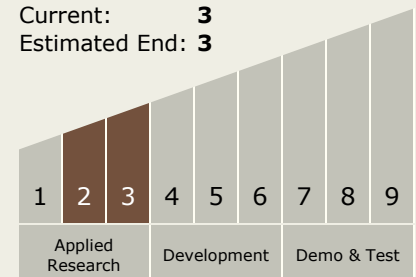**Principal Investigator:**

James Garrison

Co-Investigator:

Benjamin W Ashman

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**

Images

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Project Image Incorporation of GNSS Multipath to Improve Autonomous Rendezvous, Docking and Proximity Operations in Space
(https://techport.nasa.gov/image/1782)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  └ TX17.2 Navigation Technologies
    └ TX17.2.1 Onboard Navigation Algorithms

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For more information and an accessible alternative, please visit:
https://techport.nasa.gov/view/4307

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